Safe transfer of californium enables more analyses

The successful transfer that replenished a radioactive substance is enabling Fluor Hanford's Analytical Services 222-S Laboratory to meet requests for a wider range of analyses. During the transfer, expertise, good planning and training were credited with dramatically reducing radiological exposure.

The transfer replaced a decayed source of californium-252 with a fresh one prepared at the Oak Ridge National Laboratory. The transfer involved removing the new source from its transport cask, switching it with the old one in the irradiation chamber and then transferring the old source to the transport cask for return to Oak Ridge. The decayed source was useful for some analyses, but the new one, 100 times stronger, enables a greater variety of analyses to be conducted.

A worker prepares source transfer tubing at the 222-S neutron activation pit.

Dummy californium capsule next to a dime

The greatest challenge was to reduce radiological exposure. The californium source is smaller than a pencil, but requires a shipping cask three times the size of a human. Closed tubing and remote cable and magnet equipment were used to safely transfer the source between the shipping cask and the facility. Using techniques from the ALARA (As Low As Reasonably Achievable) program, interdisciplinary planning and training resulted in workers being shielded at every step of the process.

The new californium-252 source has a radiological reading of 1,300 rem per hour at 30 centimeters. ALARA efforts resulted in a final collective dose of 70 millirem — a dramatic reduction to less than five one-thousandths of one percent of the 1,300 rem per hour. (A rem is a radiation measurement equal to 1,000 mrem.)

The 70 mrem amount is similar to what is received by living in a brick house for a year, according to the Nuclear Energy Institute. DOE nuclear facilities are challenged to maintain a control level of no more than 500 mrem per person per year, a number well below a 2,000 mrem/year regulatory dose limit. By comparison, the average American is annually exposed to about 365 mrem from natural and man-made sources including radon, cosmic radiation, nuclear medicine and fallout.

How was ALARA implemented to achieve this significant reduction?

The first step was to review a videotape showing the old sources being placed more than 12 years ago. Comments were incorporated, along with shielding and dose calculations.

An improved method was created. It included facility development of a plastic shielding plug and transfer tubing for the cask, providing shielding while allowing totally remote source retrieval. Materials of either low neutron activation potential or short activation half lives were selected for the transfer equipment.

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As encouraged by the Integrated Environment, Safety and Health Management System, or ISMS, the work team participated in several mockups and planning sessions to ensure procedures allowed workers to implement ALARA concepts without undue restriction. An electronic portable area radiation monitoring system was used to remotely monitor the movement of the source. This system was tested nearly 30 times to ensure that everything worked properly. Then a "hot" mockup was performed in which new procedures and equipment were used to move the old sources to underground storage tubes.

Two separate high-risk reviews were performed to ensure work plans and procedures identified and mitigated this job's hazards. Before the new source arrived, a full-scale mockup was performed to ensure all members of the work team understood their parts of the operation.

Gary Troyer of Fluor Hanford, the technical authority for the source replenishment project, said its success was due to "engaging craft, radiological, and operations personnel from the start, in order to develop practical equipment and safe operating techniques."

For example, pipefitter Cliff Brower of FH Lab Maintenance developed a special access port to the source transfer tube that allowed safe release of the source from the transfer cable end magnet. Pipefitter Mike Bausch, also with Lab Maintenance, developed the actual release technique. As a result, personnel access was only necessary when the sources were in shielded conditions.

"The entire californium-252 team is congratulated on the successful completion of this phase and encouraged to continue their diligent efforts through the remainder of this job," said Owen Berglund, ALARA chairman at the 222-S Laboratory.

The first phase of replenishing the californium-252 neutron activation analysis source was successfully completed in July. An upcoming second evolution will repeat the process. ✦